



MAX-4000 Electrometer REF 90015



See **MAXCOMM** Software package for installation CD-ROM

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General Precautions

**WARNING:**

An electrical shock hazard of up to 300 VDC is possible whenever the bias voltage is active. Always set the bias to the 0% or 0 VDC level whenever a device is connected to or disconnected from the MAX-4000.

Warnings and Cautions alert users to dangerous conditions that can occur if instructions in the manual are not obeyed. Warnings are conditions that can cause injury to the operator, while Cautions can cause damage to the equipment.

**CAUTION:**

Input voltage on triax connector should be no greater than +5 V or -5 V.

**CAUTION:**

ADCL calibration is provided in the rate and/or charge modes only and is only valid for these modes. The threshold mode is not used during ADCL calibration, as pre-start and post-stop currents are not measured. These currents become part of the signal and therefore would not be accounted for in the calibration.

**CAUTION:**

Do not connect RS-232 serial port to the telephone line. This port is for connection to equipment where no risk of external voltage exists.

**CAUTION:**

When connecting or disconnecting an ionization chamber to the MAX-4000, set the bias voltage to 0% (0 VDC).

**CAUTION:**

This device should never be submerged in water or a solvent to clean, or scrubbed with an abrasive cleaner. Do not drop or mishandle unit. Calibration factor changes may result.

**CAUTION:**

Do not disassemble unit since it may result in change of calibration factor. Refer servicing to qualified individuals.

Table of Contents

PAGE	
2	General Precautions
3	General Operation
4	Front Panel
4	Rear Panel
5	Setting up the MAX-4000
7	Using the MAX-4000
9	MAX COMM Software
9	Maintenance
10	Troubleshooting
10	Parts and Accessories List
11	Features and Specifications
15	Service Policy
15	Customer Responsibility
16	Warranty



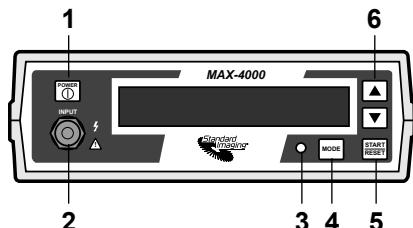
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General Operation

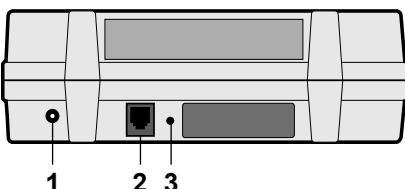
1. With nothing connected to the input jack of the MAX-4000, turn the power on and wait at least 10 minutes for the electrometer to warm up.
2. Select the desired Range of Operation, Low or High, with the arrow buttons, followed by the Mode button.
3. Press the Start button to perform the electrometer zero adjustment. This will take about one minute.
4. Connect the ionization chamber to the MAX-4000 and select the desired voltage bias. Allow at least 10 minutes for the system to stabilize.
5. Verify the leakage of the ionization chamber is within the manufacturer's stated acceptable limits.
6. Press and hold the Mode button and repeat the zeroing process in Step 3, but with the ionization chamber connected. This is the system zero adjustment.
7. Check the system leakage. Take a reading without exposing the chamber to radiation. This reading should be less than 0.1% of the final signal expected.
8. Measure the atmospheric temperature and pressure.
9. Turn on or insert the radiation source(s) and take at least 3 measurements. Further explanation of the Range, Threshold, Rate, Charge, and Rate/Charge modes can be found on pages 5-7.
10. Analyze the data taking into account the average of the readings, system leakage, temperature/pressure corrections, calibration factors and any other appropriate corrections to be made.
11. When all measurements are completed, set bias voltage to 0 VDC, turn off the MAX-4000 and disconnect the ionization chamber.

Front Panel



- 1 Power button:** Turns the unit off and on.
- 2 Input connection:** A standard two lug, BNC, triax connector for signal input. This connector features low leakage current properties. The signal current is carried on the central lead, the guard carries the high voltage and the outermost ring is ground.
To protect the input connector, always replace the chain cap when the MAX-4000 is not in use.
- 3 Battery Charging Light:** When lit, the battery charger is energized and charging the internal battery.
- 4 Mode button:** Press to toggle through the modes in the following order: Range, Bias, Threshold Levels, Rate, Charge and Rate/Charge. Press and hold for 2 seconds to select the zero adjustment procedure and perform system zero.
- 5 Start/Reset button:** Press to start and stop timed charge collections in the Charge or Rate/Charge mode, or to reset the display following a collection.
- 6 Arrow buttons:** Press to toggle the Range selection, voltages in the Bias mode, or to select the time period increments for taking a charge reading.

Rear Panel



- 1 2.1 mm Battery Charger Input:** Connect the battery charger to this input jack when charging the internal battery. Note: If the MAX-4000 is being used in a patient environment, do not plug in the charger. Connect to mains power through an isolation transformer only.
- 2 RS-232 serial port:** A standard 4 conductor telephone cable may be used to connect to the serial port for remote observation or data recording. A 15' cable and DB-9 female adapter (for connection to the computer) has been provided. Do not connect RS-232 serial port to the telephone line. This port is for connection to equipment where no risk of external voltage exists.
- 3 External reset switch:** In the unlikely event that the device stops responding, use a small diameter rod to lightly press the internal button and reset the device.

Setting up the MAX-4000

Before using the MAX-4000 to take measurements, perform the following steps to ensure accurate readings. The MAX-4000 features an automatic zero function and a convenient way to check battery status and bias level.

Auto Warm Up and Zero Adjustment

1. Turn on the MAX-4000. The display will count down a 10:00 minute warm up. The warm up may be bypassed by pressing the MODE button. If you choose to bypass the warm up, be aware that repeatability and leakage specifications may not be achieved until 10 minutes has elapsed.
2. Select the desired Range of Operation, Low or High, with the arrow buttons, followed by the Mode button. Press the Start button to perform the zero adjustment. This process will take 60 seconds.
3. The display will read "ZEROING COMPLETE." The MAX-4000 now defaults to the Bias mode.

NOTE: Each Range of Operation must be zeroed upon initial use. To perform subsequent zero adjustments, press and hold the Mode button for two seconds.

Range Selection Mode

1. The measuring range of the MAX-4000 is displayed as High or Low. The actual numeric range is also shown to indicate the proper units of measurement for each range.
2. Use the arrow buttons to select the desired range of operation. Range change is immediate.
3. Use the mode button to select mode of operation. You may use the mode button to return to the range selection mode at any time.

Bias Mode

1. The charge level of the internal battery is displayed in percent. When the battery capacity drops below 15%, the display will read "RE-CHARGE BATTERY."
2. Use the arrow buttons to select the bias level from the following options.

-100%	-300 VDC
-50%	-150 VDC
0%	0 VDC
+50%	150 VDC
+100%	300 VDC

3. Press the Mode button to select a mode of operation. You may return to the Bias mode at any time to change the bias voltage.



CAUTION:

When connecting or disconnecting an ionization chamber to the MAX-4000, set the bias voltage to 0% (0 VDC).

Threshold Levels

The MAX-4000 Electrometer has a threshold mode, which allows it to automatically detect the start and stop of a radiation exposure by measuring the current crossing predetermined limit thresholds. The start and stop thresholds are set independently, with the default settings of start 0.8 pA and stop 0.5 pA. Threshold limits cannot be set to 0.0. When making measurements in the presence of larger leakage currents, it may be necessary to raise the threshold limits. Conversely, since the start threshold

Setting up the MAX-4000 Continued

determines the minimum dose rate, it may be necessary to lower the thresholds for other measurements.

1. The threshold start and stop levels are displayed in pA and are adjustable from 0.01 - 9.99 pA.
2. Use the Start/Reset button to select the digit to adjust.
3. Use the arrow buttons to adjust the selected digit from 0 to 9.
4. Both values must be larger than zero, and the start value must be larger than the stop value.
5. Use the mode button to select mode of operation. You may use the mode button to return to the Threshold Levels mode at any time.
6. If invalid numbers are entered, the invalid entry will be displayed after pressing the Mode button.

System Zeroing

1. Connect the ionization chamber to the MAX-4000 and select the desired voltage bias. Allow at least 10 minutes for the system to stabilize.
2. Verify the leakage of the ionization chamber is within the manufacturer's stated acceptable limits.
3. Press and hold the Mode button for 2 seconds to repeat the zeroing process, but with the ionization chamber connected. This is the system zero adjustment.

Using the MAX-4000

Charging the internal battery

1. When the battery capacity is 15% or less, "RECHARGE BATTERY" appears on the display. Plug the 2.1 mm plug of the charger into the electrometer and the other end into mains power.
2. Whenever external power is supplied, the small amber light adjacent to the MODE switch on the front panel is lit. This activates the charging circuit and the Battery percent display in the Bias mode will indicate "CHRG".
3. The MAX-4000 will also operate with the charger plugged into a wall outlet, regardless of the battery capacity. Re-charging the battery takes 6 - 8 hours. The MAX-4000 may be continually charged with no detrimental effects to the internal battery.

Automatic shutdown

To maximize battery life, the MAX-4000 will shut off automatically if it is not plugged into the wall charger and is left unattended for more than 3 hours.

NOTE: Depending on the type of measurements performed, leakage currents within the ionization chamber can be a significant portion of the measured data. The electrometer zero can be adjusted to compensate for leakage currents of the ionization chamber by *pressing and holding the MODE button for 2 seconds* after the chamber has been connected and the system has warmed up. This will place the electrometer into the zeroing mode and a system zero can begin. This is applicable for the both the Rate and Charge modes. Refer to page 6 for more information on system zeroing.

Rate Mode

1. Use the Range mode to select the range of operation.
2. Use the Bias mode to set the bias voltage.
3. Use the Mode button to select the Rate Mode.
4. Irradiate the ion chamber with a radioactive source.
5. The MAX-4000 will begin to measure the current. For signals 2 nA and below, allow about 12 seconds for the signal to stabilize. For signals above 2 nA, wait about 3 seconds for stabilization.
6. The Rate measurement will be displayed.

NOTE: Rate measurements of 194.99 nA (High range) or 950.00 pA (Low range) will produce an "OVERLOAD" message.

Using the MAX-4000 Continued

Charge Mode & Rate/Charge Mode

1. Use the Range mode to select the range of operation.
2. Use the Bias mode to set the bias voltage.
3. Use the Mode button to select the Charge Mode or Rate/Charge Mode.

Select a Charge Collection Mode (Proceed to desired step 4)

<i>Timed</i>	<i>MAX RUN</i>	<i>Threshold</i>
<ol style="list-style-type: none">4. Use the arrow buttons to select the collection time. Time periods from 0 - 600 seconds are available in 15 second increments.5. Irradiate the ionization chamber.6. Press the Start/Reset button. The MAX-4000 will count down from the time set and display the charge accumulated. When the countdown is complete, the charge accumulated will remain until the unit is reset.7. Record the reading and press the Start/Reset button to clear the reading and reset to the chosen collection time.8. Repeat steps 4 - 7 for other charge readings. <p>NOTE: Charge measurements greater than 999,999 nC will produce an "OVERLOAD" message.</p>	<ol style="list-style-type: none">4. Use arrow buttons to select MAX RUN.5. Press Start/Reset button to start charge collection. The MAX-4000 will continue to collect charge until stopped by pressing the Start/Reset button.6. Irradiate the ionization chamber.7. Record the reading after irradiation period.8. Press Start/Reset to stop collection and reset reading.9. Repeat steps 4-8 for other charge readings. <p>NOTE: The charge collection is erased when stopped, so record value before stopping electrometer.</p>	<ol style="list-style-type: none">4. Use arrow buttons to select THR DET.5. Press Start/Reset button to start detection. Meter will display THR RDY.6. Irradiate the ionization chamber.7. When the threshold start level is exceeded, the MAX-4000 will begin to collecting charge and the display will change to THR TRG.8. The MAX-4000 will continue to collect charge until the measured current is below the threshold stop level. When stopped, the display will change to THR RDY.9. Record charge value.10. Repeat steps 6-10 for other charge readings.11. Press Start/Reset button to exit threshold charge collections. The display will change to THR DET.

MAX COMM Software

The MAX-4000 electrometer is compatible with Standard Imaging MAX COMM software. MAX COMM expands the functionality of a MAX series electrometer by adding chamber libraries, temperature/pressure correction factors, and more. The program installation package is included with your MAX-4000 shipment, with an enclosed CD-ROM. The MAX COMM user manual is available electronically in PDF format on the program CD-ROM and includes detailed instructions for installation, setup, and use with this electrometer.

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Maintenance

As is standard practice for other electrometers, it is recommended that the MAX-4000 be calibrated every 2 years. This calibration should be performed by an Accredited Dosimetry Calibration Laboratory.

Exterior cleaning of the device can be done with a soft brush and a cloth. Gently brush all surfaces to remove dirt and dust. Remove any remaining dirt with a cloth slightly dampened with a solution of mild detergent and water or a liquid disinfecting agent. Do not use water or liquid on triax jack. Do not permit any liquid to seep into the MAX-4000 in any manner during cleaning. It is not recommended to clean the window of the LCD with anything other than a mild detergent and a very soft cloth. Failure to use a soft cloth may result in a scratched window, and this may impair the visibility of the LCD.

Qualified users may replace the Lead Acid battery only. An illustrated Instruction Booklet is available. See the Parts and Accessories List below. There are no other user serviceable parts in the MAX-4000.



If assistance is desired in the proper disposal of this product (including accessories and components), after its useful life, please return to Standard Imaging.

Troubleshooting

Questionable Readings

If readings are off, determine if there is any leakage from the MAX-4000 or ionization chamber. Follow steps 1 - 7 under General Operation.

Can't Get Out of Charge Mode or Rate/Charge Mode

Upon completion of a charge collection in the Charge mode or Rate/Charge mode, the Start/Reset button must first be pressed to reset the display before other buttons will function.

No Response

If the system does not respond to any of the buttons, use the external reset switch. See page 4 for details.

Low Battery

The MAX-4000 contains 1 rechargeable sealed lead-acid battery with a life of about 10 hours. When the battery is at 15% of capacity, "RECHARGE BATTERY" will appear on the display. If the battery becomes low during a charge collection, the screen will alternate between "RECHARGE BATTERY" and the status of the collection. The collection process will not be interrupted.

The MAX-4000 will also operate with the charger plugged into a wall outlet. Re-charging the battery takes 6 - 8 hours. The MAX-4000 may be continually charged when not in use with no detrimental effects to the internal battery.

The MAX-4000 will shut off automatically if it is not plugged into the wall charger and is left unattended for more than 3 hours.

If you require further assistance, please contact Standard Imaging's Service Department at (800) 261-4446 or (608) 831-0025 for international calls.

Parts and Accessories List

REF	Description
80206	Instruction Manual
72011	Battery Charger, 110 VAC*
76007	Battery Charger, 220 VAC*
72013	Telco® Adapter Kit, RJ-11 to DB-9F
73006-110	Lead Acid Battery Replacement Kit, including 110 VAC wall charger
73006-220	Lead Acid Battery Replacement Kit, including 220 VAC wall charger
75501	MAX COMM Software
4426	Technical Note-Command Set for Bi-directional RS-232 operation.

Features and Specifications

Rate Mode Ranges:	Low: 0.001 pA - 950.00 pA High: 0.001 nA - 195.00 nA
Charge Mode Ranges:	Low: 0.01 pC - 999,999 nC High: 0.01 nC - 999,999 nC
Charge Collection Modes:	Timed charge collection Continuous charge collection Threshold controlled charge collection
Threshold Levels for charge collection:	Start: 0.02 - 9.99 pA Stop: 0.01 - 9.98 pA Start value must be larger than stop value
Selectable Time Periods for Charge Collection:	Range: 15 - 600 seconds Increments: 15 seconds Resolution: 1 second
Range Switching:	User selectable
Repeatability:	Short term: $\pm 0.1\%$ + one count Long term: $\pm 0.2\%$ (max change over 2 yrs) Signal settling time (typ): High Range - 12 sec Low Range - 3 sec
Linearity:	$\pm 0.06\%$ typical, all rate and charge settings
Leakage (Zero Drift):	Low Range < 1 fA at STP High Range < 5 fA at STP
Operating Conditions:	Pressure: 680 to 770 mm Hg Temperature: 10 to 40 °C Relative Humidity: 20 to 80%, non-condensing
Storage and Transport Conditions:	Pressure: 600 to 800 mm Hg Temperature: -15 to 50 °C Relative Humidity: 10 to 95%, non-condensing

Specifications are subject to change without notice.

Features and Specifications Continued

Display:	LCD, 2 x 20 with 5/16 in. high characters
Input:	BNC two lug, triaxial connector
Bias Voltage: Five user settings:	Nominal ± 300 volt bias -300, -150, 0, 150, 300 (VDC)
Zeroing:	Automatic zero function, user activated
Output:	Isolated RS-232, Default: uni-directional 19,200 baud, 8 data bits, no parity, 1 stop bit Bi-directional operation via 1) Argus QC4 Software 2) User provided-request Tech Note Doc No. 4426.
Dimensions:	
Width:	22.2 cm (8.24 in)
Height:	7 cm (2.75 in)
Length:	23 cm (9 in)
Weight:	1.4 kg (3.0 lbs)
Power Requirements:	UL listed wall-mounted power supply, 110 or 220 VAC input, 9 VDC@300 mA output
Product Standards:	IEC 60601-1, ¹ IEC 60601-1-2, ¹ IEC 60731 ₂  0413

Specifications are subject to change without notice.

Notes

Notes

Service Policy

If service, including recalibration, is required, please contact Standard Imaging's Customer Service department by phone or email prior to shipping the product. Standard Imaging's Customer Service and Technical Service staff will attempt to address the product issue via phone or email. If unable to address the issue, a return material authorization (RMA) number will be issued. With the RMA number, the product can be returned to Standard Imaging. It is the responsibility of the customer to properly package, insure and ship the product, with the RMA number clearly identified on the outside of the package. The customer must immediately file a claim with their carrier for any shipping damage or lost shipments. Return shipping and insurance is to be pre-paid or billed to the customer, and the customer may request a specific shipper. Items found to be out of warranty are subject to a minimum service fee of 1 hour labor (excluding recalibrations) for diagnostic efforts and require a purchase order (PO) before service is performed. With concurrence from customer, the product may be replaced if it is unserviceable or if the required service is cost prohibitive. Products incurring service charges may be held for payment. Standard Imaging does not provide loaner products. See the Standard Imaging Warranty and Customer Responsibility for additional information.

Standard Imaging products have unit serial numbers with coded logic which indicates the product, day and year of manufacture, and a sequential unit number for identification:

E YY DDD X

E MAX-4000 Product Line
YY Last two digits of the year
(e.g. 1999 = 99, 2000 = 00)
DDD Day of the year ($1 \leq DDD \leq 365$)
X Unique unit ID Number ($1 \leq X \leq 9$)

Customer Responsibility

This product and its components will perform properly and reliably only when operated and maintained in accordance with the instructions contained in this manual and accompanying labels. A defective device should not be used. Parts which may be broken or missing or are clearly worn, distorted or contaminated should be replaced immediately with genuine replacement parts manufactured by or made available from Standard Imaging Inc.

⚠ CAUTION: Federal law in the U.S.A. and Canadian law restrict the sale, distribution, or use of this product to, by, or on the order of a licensed medical practitioner. The use of this product should be restricted to the supervision of a qualified medical physicist. Measurement of high activity radioactive sources is potentially hazardous and should be performed by qualified personnel.

Should repair or replacement of this product become necessary after the warranty period, the customer should seek advice from Standard Imaging Inc. prior to such repair or replacement. If this product is in need of repair, it should not be used until all repairs have been made and the product is functioning properly and ready for use. After repair, the product may need to be calibrated. The owner of this product has sole responsibility for any malfunction resulting from abuse, improper use or maintenance, or repair by anyone other than Standard Imaging Inc.

The information in this manual is subject to change without notice. No part of this manual may be copied or reproduced in any form or by any means without prior written consent of Standard Imaging Inc.

Warranty

Standard Imaging, Inc. sells this product under the warranty herein set forth. The warranty is extended only to the buyer purchasing the product directly from Standard Imaging, Inc. or as a new product from an authorized dealer or distributor of Standard Imaging, Inc.

For a period provided in the table below from the date of original delivery to the purchaser or a distributor, this Standard Imaging, Inc. product, provided in the table is warranted against functional defects in design, materials and workmanship, provided it is properly operated under conditions of normal use, and that repairs and replacements are made in accordance herewith. The foregoing warranty shall not apply if the product has been altered, disassembled or repaired other than by Standard Imaging, Inc. or if the product has been subject to abuse, misuse, negligence or accident.

Product	Warranty Period
Standard Imaging Ionization Chambers	2 years
Standard Imaging Well Chambers	2 years
Standard Imaging Electrometers	2 years
Standard Imaging Software Products	1 year
All Other Standard Imaging Products	1 year
Standard Imaging Custom Product	90 days
Consumables	90 days
Serviced Product	90 days
Resale Products	As defined by the Original Equipment Manufacturer
ADCL Product Calibration (Standard Imaging uses the UW-ADCL for recalibrations required under warranty)	0 - 90 days = 100% of ADCL Calibration Costs 91 - 182 days = 75% of ADCL Calibration Costs 183 - 365 days = 50% of ADCL Calibration Costs 366 - 639 days = 25% of ADCL Calibration Costs (days from date of shipment to customer)

Standard Imaging's sole and exclusive obligation and the purchaser's sole and exclusive remedy under the above warranties are, at Standard Imaging's option, limited to repairing, replacing free of charge or revising labeling and manual content on, a product: (1) which contains a defect covered by the above warranties; (2) which are reported to Standard Imaging, Inc. not later than seven (7) days after the expiration date of the warranty period in the table; (3) which are returned to Standard Imaging, Inc. promptly after discovery of the defect; and (4) which are found to be defective upon examination by Standard Imaging Inc. Transportation related charges, (including, but not limited to shipping, customs, tariffs, taxes, and brokerage fees) to Standard Imaging are the buyer's responsibility. This warranty extends to every part of the product except consumables (fuses, batteries, or glass breakage). Standard Imaging, Inc. shall not be otherwise liable for any damages, including but not limited to, incidental damages, consequential damages, or special damages. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days.

This warranty is in lieu of all other warranties, express or implied, whether statutory or otherwise, including any implied warranty of fitness for a particular purpose. In no event shall Standard Imaging, Inc. be liable for any incidental or consequential damages resulting from the use, misuse or abuse of the product or caused by any defect, failure or malfunction of the product, whether a claim of such damages is based upon the warranty, contract, negligence, or otherwise.

This warranty represents the current standard warranty of Standard Imaging, Inc. Please refer to the labeling or instruction manual of your Standard Imaging, Inc. product or the Standard Imaging, Inc. web page for any warranty conditions unique to the product.